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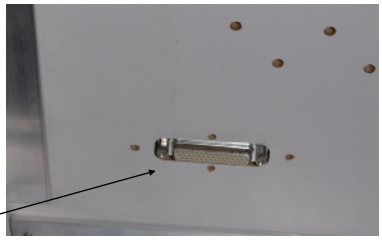
# Parts Checklist

## The Digitizer System consists of:

- Digitizer 3x1 Series digitizing tablet
- Digitizer-Controller
- Digitizer-Interface-Cable with 44-pin connector
- Host interface cable with 9-pin connector
- Cordless Pointing Device
- Charger

**Note:** The Digitizer-Controller is a small enclosure and attached via the Digitizer-Interface-Cable to the back of the tablet. The controller contains the electronics that drive the Digitizer.

**Picture 1-1**

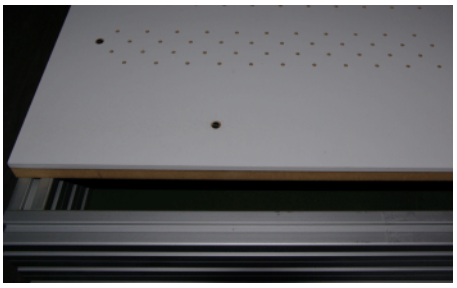



# What you need to use the Digitizer

- A Host with an RS232 Communication port
- Graphic application software that accepts digitizer input
- Optional a Vacuum-System at the back of the tablet

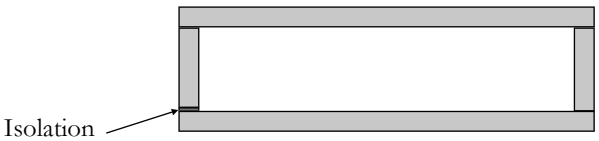
# Mounting the Digitizer tablet

**Picture 3-1**



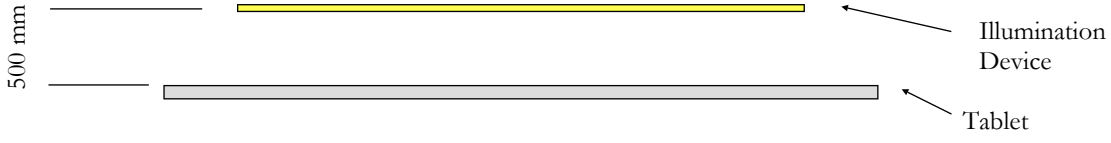
You can mount the tablet on a stable Al-Frame (s. Picture 3-1). Be sure that the mounting-frame builds not an electrical closed frame, because that decrease the magnetic field produced by the wires inside the tablet (s. Picture 3-2).

**Picture 3-2**




The minimum distance between the table and an extra illumination device is 500mm (s. Picture 3-3). Use an illumination device with low electrical and magnetic field emission, for example an LED-Illumination.

**Picture 3-3**



# Introduction

This document describes the command interface between a Host and the Digitizer. The Digitizer uses two output-formats, ASCII and binary. All commands from the Host are in ASCII-Format which can be send online or manually (use a terminal emulation program e.g. Tera Term). Any command can be given at any point of time even during an active data connection. Each command line sent to the Digitizer consists of a body (if applicable) and a terminator.

The command-line uses ASCII-Characters in the range from 32 to 127. Control characters other than <CR> and <STX> (carriage return → ASCII 0x0D - Start of Text → ASCII 0x02) in a command line are disregarded. Characters are case sensitive.

Parameters must be with minimum of one Blank-Character. The first value after each parameter must be followed immediately, subsequent values are comma separated.

**Terminator is <CR>.**

There are two types of responses - information text and result codes - which are sent back to the Host. Information text may consist of a single line or multiple lines and are always ASCII-Characters. Result codes may be transmitted in ASCII-Format or Binary-Format depending of Parameter "F" in the initialization command.

Connection between the Host and the Digitizer uses a RS232 interface with the following settings:

**38400 bps, 8 data bits, no parity, 1 stop bit (8/N/1), no handshake.**

Power on the Digitizer and remain until the startup message is received.

**Startup Message:** >Digitizer v.x.x

Subsequent to received the Startup Message the Digitizer must be initialized. If one provides a new command the prior command will be suspended except for the init-command.

# Commands

## init — Initialisation of the Digitizer

Init allows you to initialize the Digitizer with various parameters. You must provide this command after receiving the Startup Message when the Digitizer is powered on. You would also have to provide this command when changing the Pointing-Device. Furthermore, you could provide this command to reinitialize the Digitizer.

**Syntax:** *init N[n1,n2,n3,n4] F[format] M[mode] K[key] E[echo]*<CR>

**Parameter N** → Serial number from the Pointing-Device (Factory setting)
N[n1,n2,n3,n4]

- n1,n2,n3: values from 0 to 255
- n4 even-numbered values from 0 to 254

Example:
N12,255,0,4 → serial number 12 255 0 4

**Parameter F** → Output-Format
F[format]

- 1 = ASCII-Format
- 2 = Binary Format

Example:
F1 Data-Format: ASCII

**Parameter M** → Scan-Mode
M[mode]

- 1 = Scan one time after a valid scan-command
- 2 = Scan continuously after a valid init-command

Example:
M1 Scan one time after a valid scan-command

**Parameter K** → Key-Mode
K[mode]

- 1 = Key is active one time after actuated
- 2 = Key is active as long as actuated

Example:
K1 Key is active one time after actuated

**Parameter E** → Command-line Echo
E[echo]

- 1 = Echo on
- 2 = Echo off

Example:
E2 Echo off (no echo of the command-line and no information text)

# Commands

## Q Query

Query returns the x/y-Position, the Key-Code and Status-Information in ASCII or Binary-Format depending of the "F" Parameter in the init-command. For this command no body is required.
The Digitizer has two different scan-modes, depending on the M-Parameter given by the init-command. In asyncron scan-mode (M-Parameter=1), the query-command initiate one scan and the Digitizer responds with a return-information. In syncron scan-mode (M-Parameter=2), the query-command returns the latest scan-information from the Digitizer.

**Syntax:** Q<*CR*>

Returnd Values in ASCII_FORMAT as followed

**Table 5-1**

| | | | |
|---|---|---|---|
| 1. Character | Start of Text | STX | 0x02 |
| 2. Character | Status | 0 … 3 | 0x30 … 0x33 |
| 3. Character | Key-Code | 0 … 6 | 0x30 … 0x36 |
| 4. Character | x-Coordinate high | 0 … 9 | 0x30 … 0x39 |
| 5. Character | x-Coordinate | . | . |
| 6. Character | x-Coordinate | . | . |
| 7. Character | x-Coordinate | . | . |
| 8. Character | x-Coordinate low | . | . |
| 9. Character | y-Coordinate high | . | . |
| 10.Character | y-Coordinate | . | . |
| 11.Character | y-Coordinate | . | . |
| 12.Character | y-Coordinate | . | . |
| 13.Character | y-Coordinate low | . | . |

**Status:** 0 = Key-Code and x/y-coordinates are valid values
1 = Key-Code and x/y-coordinates are valid values and Low-Batterie is active
2 = Cursor is out of proximity
3 = Cursor is out of proximity and Low-Batterie is active

**Key-Code:** 0 = No Key is activated
1 = Key 1 is activated
2 = Key 2 is activated
3 = Key 3 is activated
4 = Key 4 is activated
5 = Key 5 is activated
6 = Key 6 is activated

**x/y-coordinate:**
The unit of the x/y-coordinate is 0.1 mm

# Q Query

Returnd Values in Binary-Format as followed

**Table 5-2**

| Byte | Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Status | 1 | 1 | 0 | 0 | 0 | 0 | Bat | Pr |
| 2 | Key-Code | 0 | 0 | 0 | 0 | 0 | k2 | k1 | k0 |
| 3 | x-Coordinate low-order Byte | 0 | 0 | x5 | x4 | x3 | x2 | x1 | x0 |
| 4 | x-Coordinate | 0 | 0 | x11 | x10 | x9 | x8 | x7 | x6 |
| 5 | x-Coordinate high order Byte | 0 | 0 | 0 | 0 | x15 | x14 | x13 | x12 |
| 6 | y-Coordinate low-order Byte | 0 | 0 | y5 | y4 | y3 | y2 | y1 | y0 |
| 7 | y-Coordinate | 0 | 0 | y11 | y10 | y9 | y8 | y7 | y6 |
| 8 | y-Coordinate high order Byte | 0 | 0 | 0 | 0 | y15 | y14 | y13 | y12 |

**Status**
The highest two bits in the Status-Byte are always "1". This indicates the launch of a data transfer and can easily be used for synchronization In all subsequent bytes the highest two bits are zero.

Pr = 0 Cursor in active area
Pr = 1 Cursor out of proximity

Bat = 0 Battery OK
Bat = 1 Low Batt is active

**Table 5-3**

| Key-Code | | | |
|---|---|---|---|
| **Key-Number** | **k2** | **k1** | **k0** |
| No Key | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 |
| 3 | 0 | 1 | 1 |
| 4 | 1 | 0 | 0 |
| 5 | 1 | 0 | 1 |
| 6 | 1 | 1 | 0 |

**x/y-coordinate**
The unit of the x/y-coordinate is 0.1 mm

# Digitizer Block Diagram

The principal Digitizer configuration are shown in the simplified block diagram in Figure 6-1. There are three parts which are used to implement one Digitizer:

- The Controller
- The Tablet
- A Cordless Pointing Device

All three parts are described in more detail later in this chapter. The Digitizer uses only one external Power Supply (24 VDC). Communication between a Host-Computer and the Digitizer uses a standard RS232 connection with a simple protocol which are described in chapter Query on page 4 and 5.

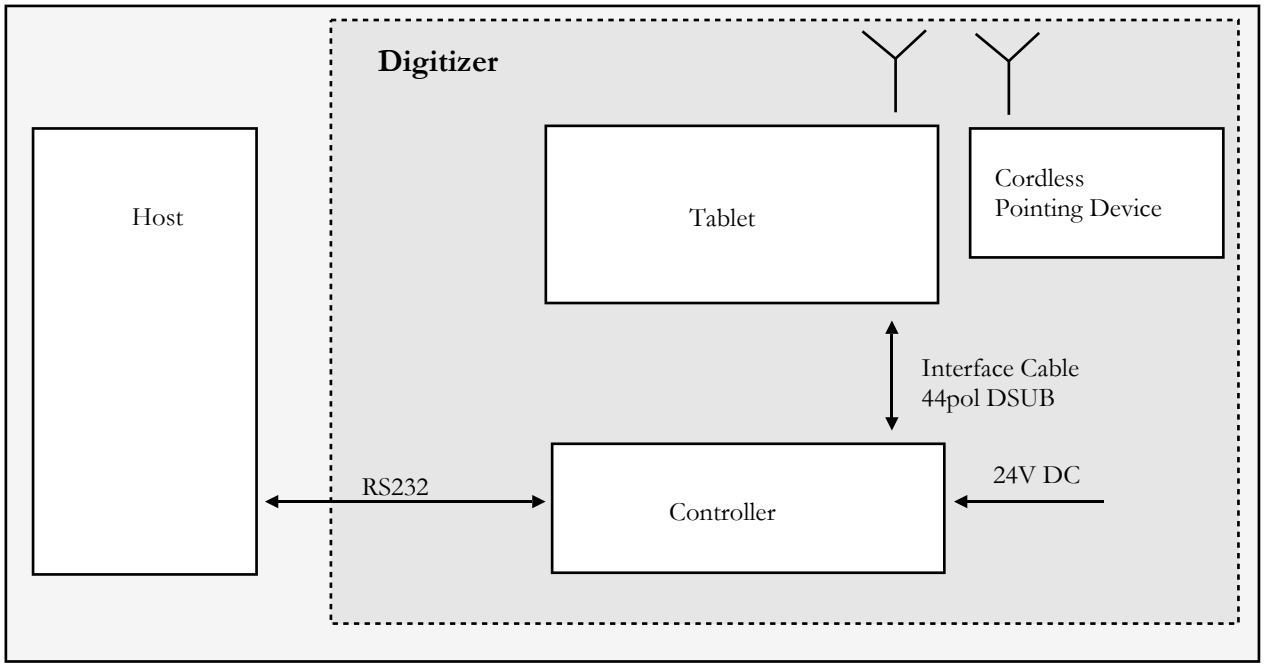



**Figure 6-1**

# Controller Block Diagram

The Controller is divided in to three parts (see Figure 7-1):

- The Power Supply
- The FPGA-Board with Logic and a 32Bit Softprocessor
- The Driver-Board

All three parts are covered in a small case (Picture 7-1 on the right side)
The mechanical dimensions of the case are described later in this chapter.

**Picture 7-1**

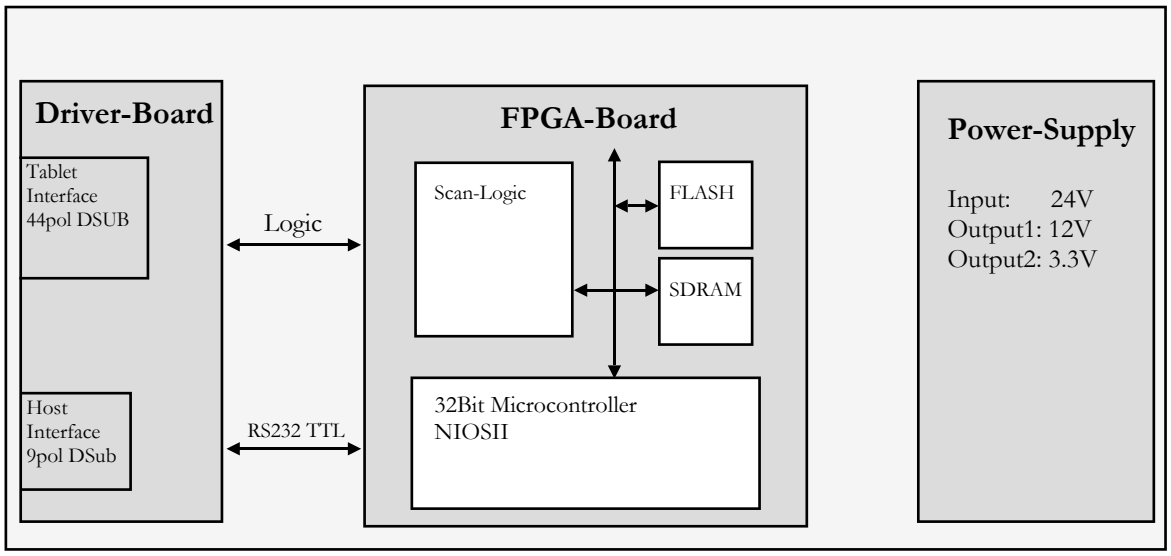



**Figure 7-1**

## Power Supply

The power supply is integrated on the Driver-Board.

**Specification**

| | |
|---|---|
| Input: | 24VDC 1A |
| Output 1: | 12V |
| Output 2: | 3.3V |

## FPGA-Board

The main part of this board is a FPGA (Altera Cyclone III). The FPGA contains a 32Bit Softprocessor NIOS II and the necessary logic to scan the wires on the tablet.

## Driver Board

The Driver-Board connects the controller and the tablet over a 44-pin Connector. For optimal noise immunity all logic signals are converted to a 3.3V-RS422 like differential signal.

# Controller Mounting Information

The main measures of the controller case are shown in Figure 7-2.

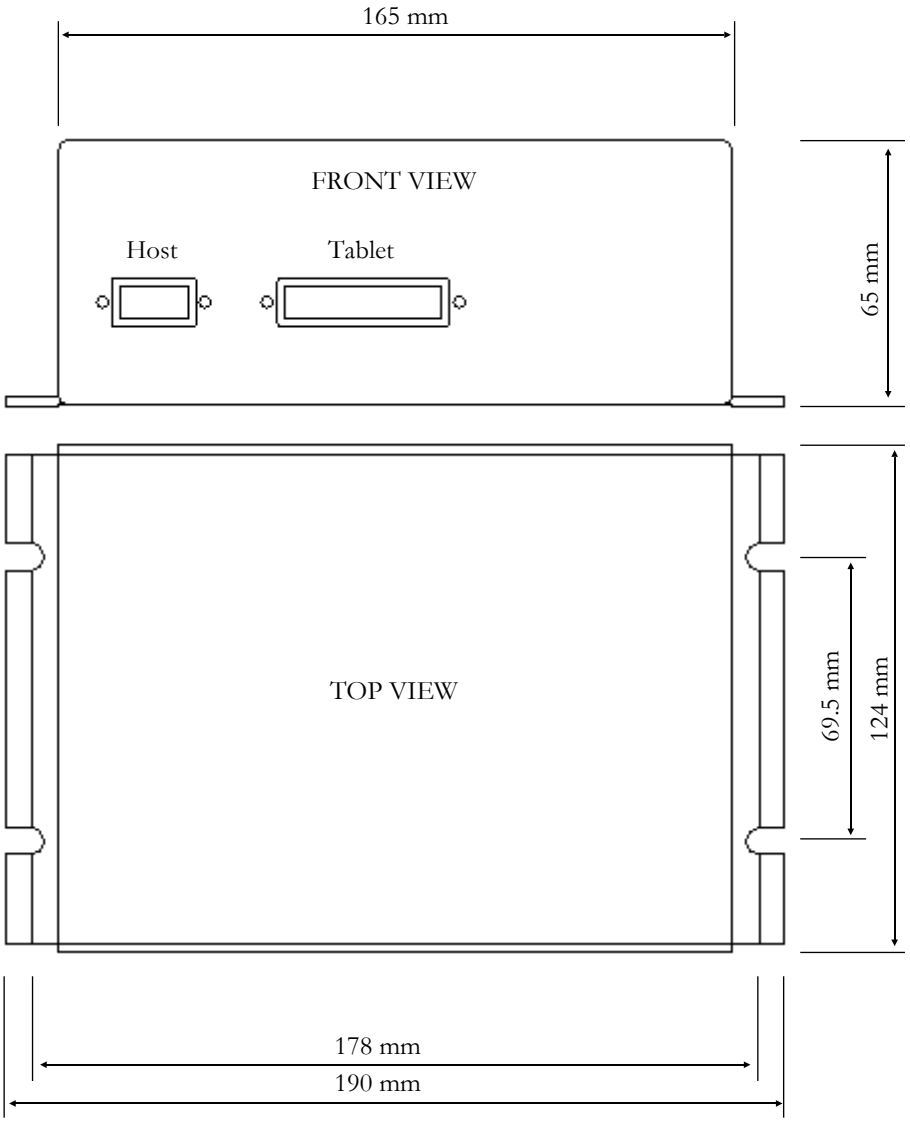



**Figure 7-2**

# Controller Connectors

This chapter contains information about the I/O connectors on the front panel and back panel of the Digitizers Controller, including pinouts and signal descriptions for each connector.

Table 7-1 summarizes the functions of the connections and the controls on the Digitizers front and back panel

Figure 7-3 shows the front panel layout and Figure 7-4 shows the back panel for a Digitizers Controller.

**Table 7-1**

| I/O Interface | External Connector | Description |
|---|---|---|
| -1- Serial | 9-pin DSUB male | RS232 Serial Port |
| -2- Tablet | 50-pin DSUB male | External Twisted-Pair I/O-Signals |
| -3- Fuse | | 1 A |
| -4- Power | 3-pin Power connector | 18 - 36 V DC reverse polarity protected |
| -6- Switch | | Power ON/OFF Switch |

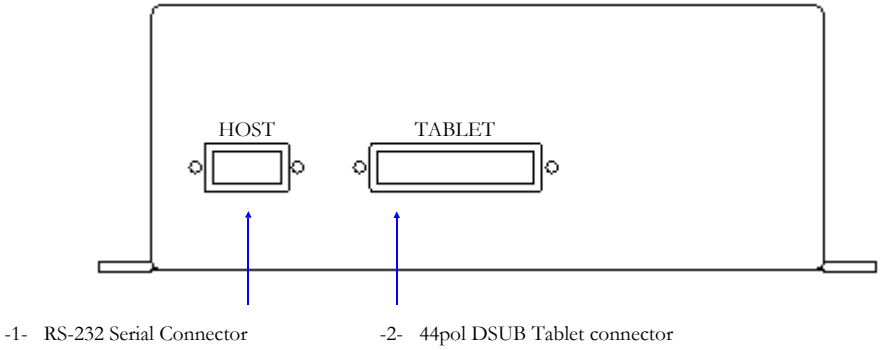



**Figure 7-3**

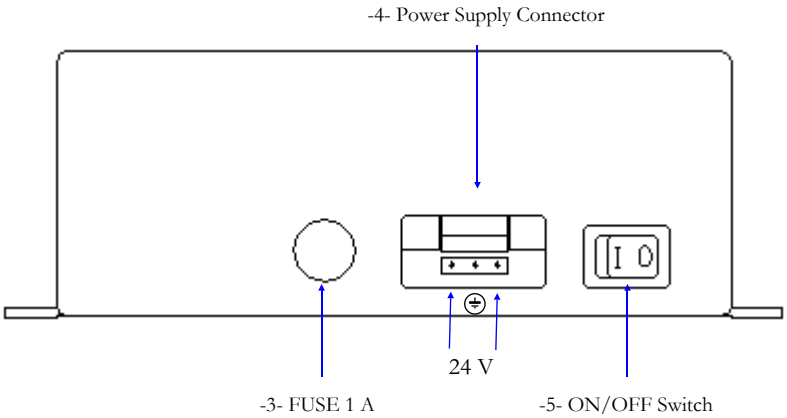



**Figure 7-4**

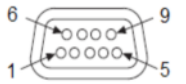
# RS-232 Serial Connector

Table 7-2 lists and describes the RS-232 serial connector signals. Picture 7-1 shows the location of the Pin-Number from the 9 pin DSUB female connector.

**Table 7-2**

| RS-232 Serial Connector | | |
|---|---|---|
| Pin | Signal Name | Signal Description |
| 1 | n.u. | |
| 2 | TxD | Transmit Data |
| 3 | RxD | Receive Data |
| 4 | n.u. | |
| 5 | GND | Ground |
| 6 | n.u. | |
| 7 | n.u. | |
| 8 | n.u. | |
| 9 | n.u. | |

**Picture 7-1**



Serial Female Connector

**Internal connection**
Pin 1,4 and 6 are connected together
Pin 6 and 7 are connected together

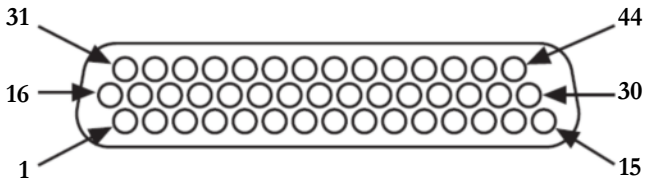
# Tablet Connector

Table 7-3 lists and describes the connector signals between the Controller and the Tablet. Picture 7-2 shows the location of the Pin-Number from the 44 pin DSUB female connector.

**Table 7-3**

| Pin | Signal Name | Signal Description | Pin | Signal Name | Signal Description | Pin | Signal Name | Signal Description |
|---|---|---|---|---|---|---|---|---|
| 1 | +3.3V | | 16 | +3.3V | | 31 | +3.3V | |
| 2 | ySHCP+ | y-Shift-Clock + | 17 | xSTCP+. | x-Store-Data-Clock+ | 32 | P2.4- | |
| 3 | ySHCP- | y-Shift-Clock - | 18 | xSTCP-. | x-Store-Data-Clock- | 33 | P2.4+ | |
| 4 | y/MR+ | y-Reset-Shift-Register+ | 19 | x485+ | x-Shift-Data+ | 34 | P4.3+ | |
| 5 | y/MR- | y-Reset-Shift-Register- | 20 | x485- | x-Shift-Data- | 35 | P4.3- | |
| 6 | GND | Signal Ground | 21 | GND | Signal Ground | 36 | GND | +12V-Ground |
| 7 | ySTCP+. | y-Store-Data-Clock+ | 22 | P4.6+ | | 37 | P2.2- | |
| 8 | ySTCP-. | y-Store-Data-Clock- | 23 | P4.6- | | 38 | P2.2+ | |
| 9 | GND | Signal Ground | 24 | GND | Signal Ground | 39 | +12V | |
| 10 | y485+ | y-Shift-Data+ | 25 | P4.5+ | | 40 | P2.3+ | |
| 11 | y485- | y-Shift-Data- | 26 | P4.5- | | 41 | P2.3- | |
| 12 | +3.3V | | 27 | P2.0- | | 42 | P2.0+ | |
| 13 | xSHCP+ | x-Shift-Clock + | 28 | P4.4- | | 43 | P2.1+ | |
| 14 | xSHCP- | x-Shift-Clock - | 29 | P4.4+ | | 44 | P2.1- | |
| 15 | x/MR+ | x-Reset-Shift-Register+ | 30 | x/MR- | x-Reset-Shift-Register- | | | |

**Picture 7-2**



# Tablet

The tablet shown in Figure 8-1 consists of a Tablet-Adapter with an integrated RF-Module for communication with the Pointing Device and the necessary x- and y-wire-driver. The distance between each wire in x- and y-direction is 20mm. The maximum active scan-area in x- and y-direction can calculated from the following formula:

**Scan-area in x- or y-direction = (((n x 16) - 1) x 20mm) - 80mm**

Where "n" is the number of boards of the corresponding x- or y-direction

**Example:** 10 boards in x-direction - all wires connected
3 boards in y-direction - all wires connected

Calculation in x- direction: x-scan = (((10 x 16) - 1) x 20mm) - 80mm = 3100mm
Calculation in x- direction: y-scan = (((3 x 16) - 1) x 20mm) - 80mm = 860mm

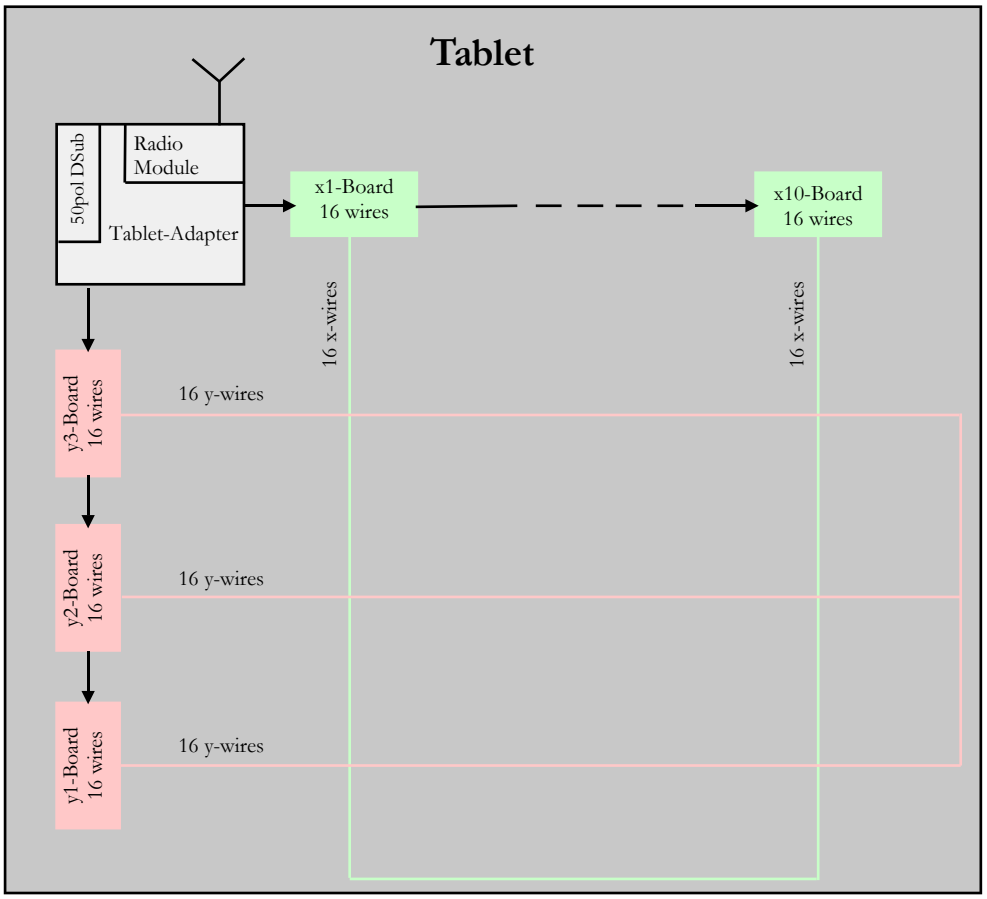
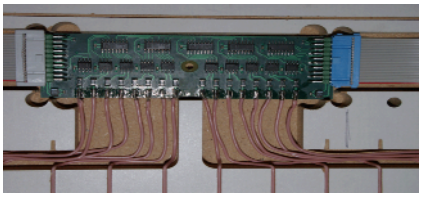



**Figure 8-1**

**Picture 8-1**

Picture 8-1 shows one x-board that can drive 16 wires. Connection to the next board is made via a 20pol flat cable.



# Zero Point and Top Right Definition

The zero point definition is shown in Figure 8-2 Detail "A". It is 40mm away from the first wire in either x- and y-direction. The top right definition in Figure 8-2 Detail "B". It is 40mm away from the last wire in either x- and y-direction

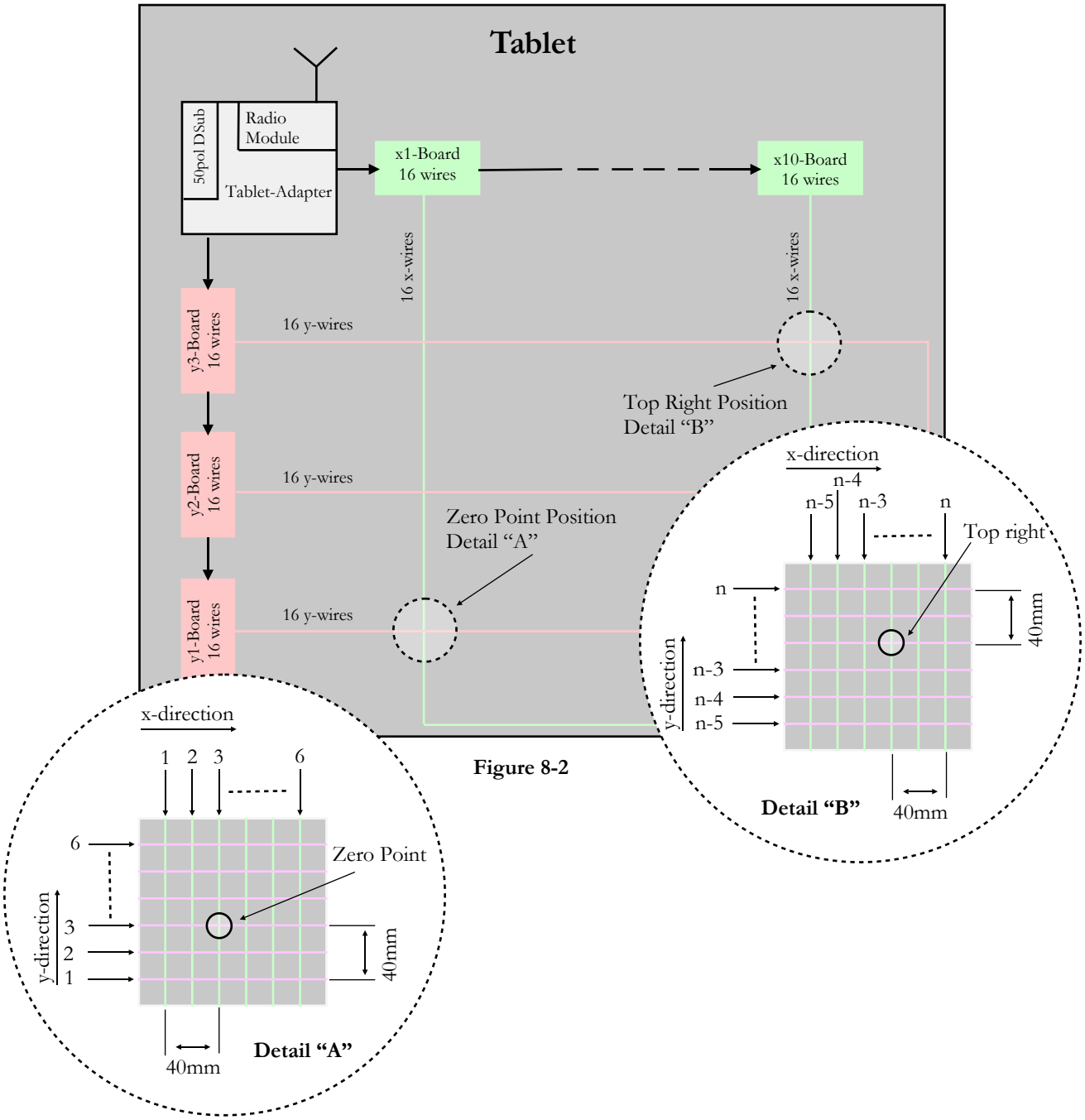



**Figure 8-2**

# Mounting Information

The Tablet consists of three parts. Two cover plats and one base plate. All plates contains hole for vacuum (s. Detail "D"). The vacuum case has to be mounted by the user. All electronic components for wire activation are mounted in the base plate (s. Figure 8-1 on page 13). Figure 8-5 Detail "C" shows the position of the 44 pin DSUB tablet connector.

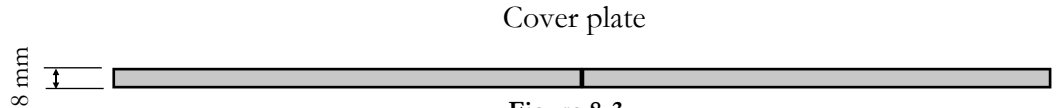



**Figure 8-3**

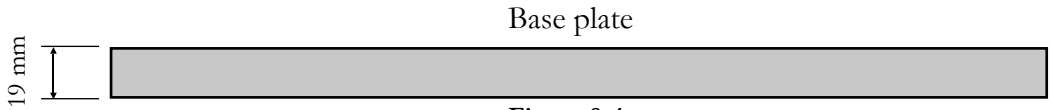



**Figure 8-4**

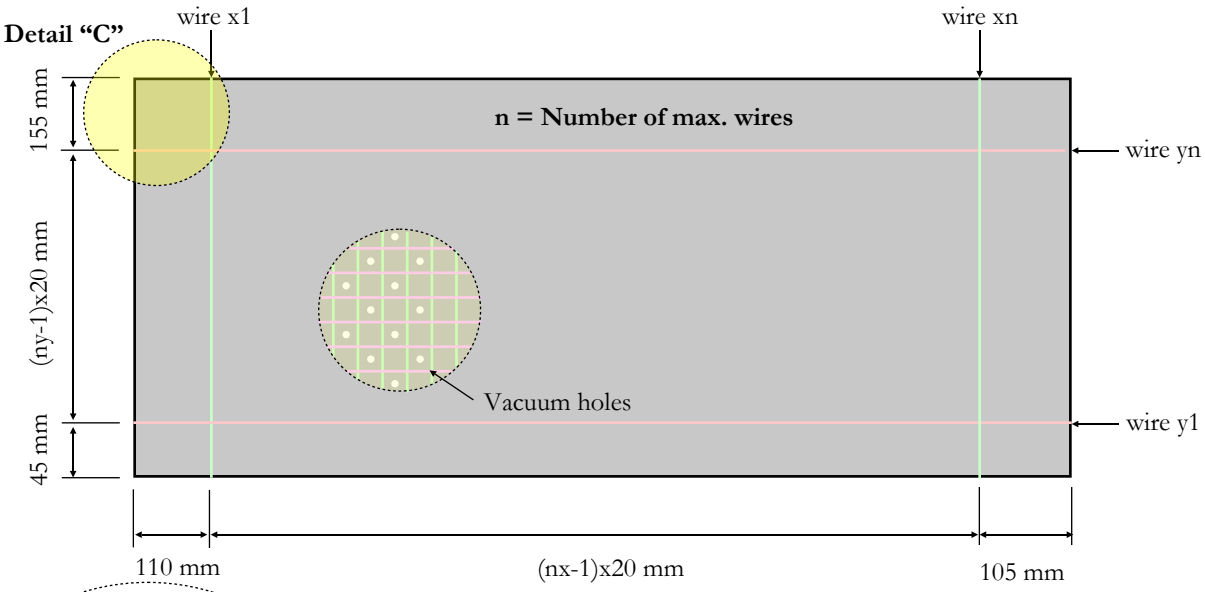
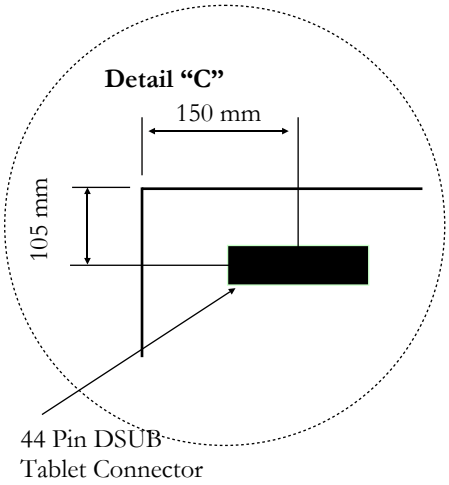



**Figure 8-5**



# Pointing Device

A simplified Logic Diagram of the Pointing Device is shown in Figure 9-1 (some features not shown). The Circuit-Board contains the necessary Filter and Amplifier to detect the magnetic field generated from the wires inside the tablet. The MPS430 Microcontroller digitizes the received analog magnetic field and send this information to the tablet over air. Furthermore the Microcontroller scans the keys and detect a low voltage of the battery.
The Pointing Device contains a Lithium Polymere Battery to operate about 10 hours without charging.

The main measures of the Pointing Device is shown in Picture 9-1.

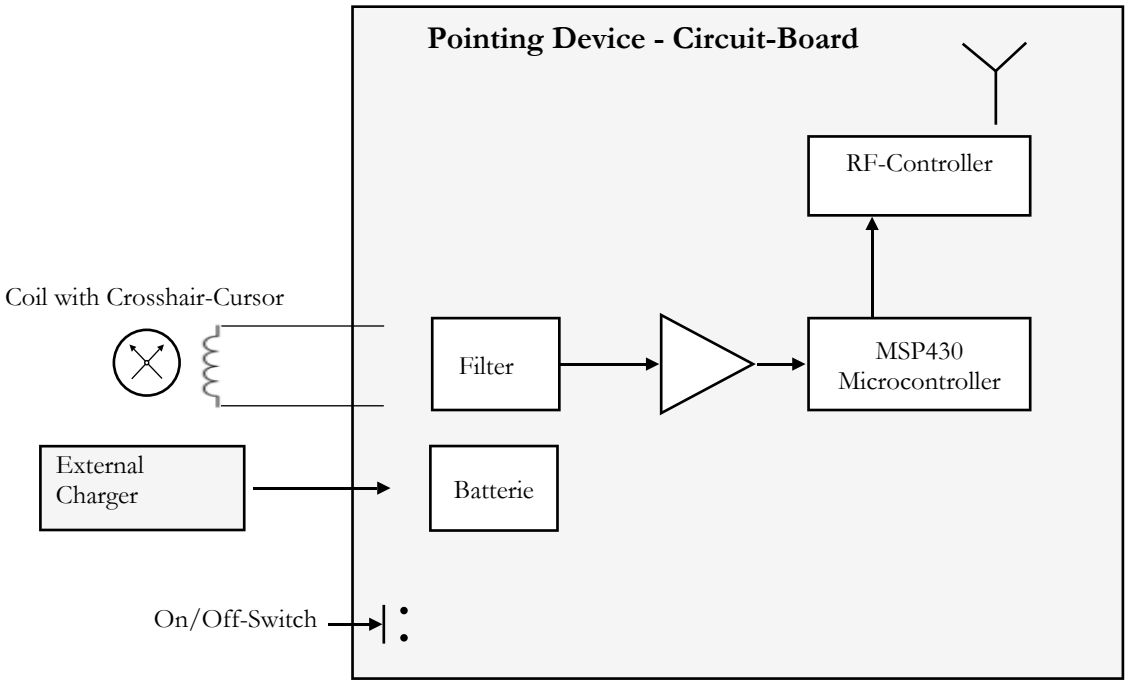
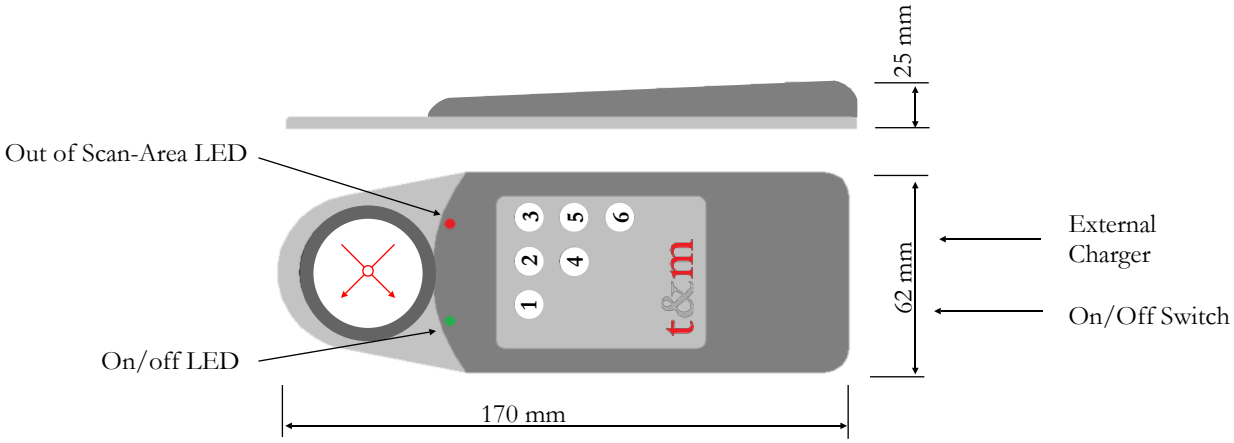



**Figure 9-1**

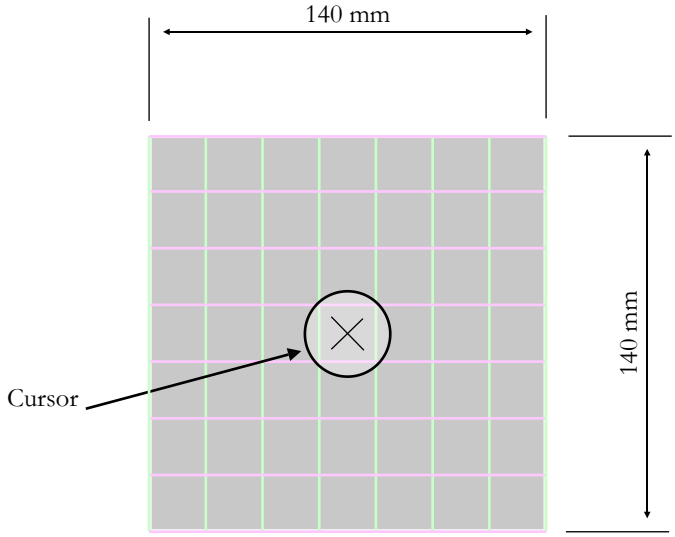
**Picture 9-1**



# Scan-Algorithm

In this chapter the principal scan-algorithm is explained. The most efficient method takes place, if the M-parameter in the init command is = "2". Picture 10-1 shows the simplified dynamic scan area anywhere in the entire tablet.

**Picture 10-1**




Dynamic Scan-Area 140mm x 140mm

The dynamic scan-area follows the movement of the cursor. The cursor is approximately in the middle of this area, except on the boundaries of the tablet. This area can be lost, if the movement of the cursor is grater then 900mm/sec. In case of lost this area, a scan over the whole tablet takes place automatically to readjust the dynamic scan-area.

The algorithm calculates the number of the x- and y-wire left and below the pointing devices crosshair. An interpolation between this wire and the next wire will be used to calculate the accurate position of the crosshair cursor. This will be done in both directions x and y.